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DEVELOPMENT OF ELECTRICAL MACHINERY CONSTRUCTION AT THE "ELEKTROSILA" PLANT IMENI S. M. KIROV

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An independent electrical industry did not exist in prerevolutionary Russia. This extremely important branch of the national economy was in the hands of foreign capitalists. The technical phase of construction was carried out abroad. The electrical plants in Russian were in reality only workshops.

After the October Revolution, the Soviet electrical industry achieved its independence and began to develop rapidly. The "Elektrosila" Plant assumed an important role in the development of heavy electrical machinery.

Achievement of the GOELRO (State Commission for Electrification of the Republic) plan required the organization of turbine and generator construction. Production of turbogenerators at "Elektrosila" began in 1924. In 1947, the first generators were built for the Volkhovstroy and the production of turbogenerators of 24,000-kilowatt capacity was begun.

Thus, the period from 1922-1927 witnessed the creation of a base for heavy electrical machine building at "Elektrosila." Around the beginning of the Stalin Five-Year Plans, the plant's production area and output increased almost three times in comparison with prerevolutionary figures.

However, the tempo of plant development increased still more during the Stalin Five-Year Plans when power plants and industry had to be supplied with electrical equipment.

In 1937, the factory produced a unique two-pole turbo-generator with a 100,000-kilowatt rating.

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During the Third Five-Year Plan, up to the beginning of World War II, enormous generators, with an outer diameter about 15 meters, and weighing about 1,200 tons, were produced, and work was begun on hydrogen cooling of synchronous compensators and turbogenerators.

The war seriously affected the production of "Elektrosila," but during the blockade of Leningrad, plant operations were not curtailed for a single day.

Below is a short synopsis of the development of electrical machine building at "Elektrosila."

1. Turbogenerators

Turbogenerator construction began at "Elektrosila" in 1923. Work was started on two-pole generators with massive cylindrical rotors having forged-steel bands which enclosed the end winding of the rotor.

For the first 10 years (approximately to 1933), turbogenerator production at "Elektrosila" emphasized the development of designs corresponding, in stator and rotor windings and in ventilation features, to the turbogenerators employed in Europe. However, the turbogenerators of this series already had a considerable advantage, from the standpoint of technical and economical properties, over turbogenerators of certain foreign firms and the AEG in particular.

The experience of the first 10 years made it possible to introduce many improvements when the transition was made to Series T which had been worked out on new construction and production principles. This series had duplex or double-layer winding with continuous compound insulation. The rotor had baked-on insulation. The machines were provided with a multilateral system of ventilation which feeds fresh air through the whole length of the machine.

Tests of the first models of the Series T machine not only confirmed calculations, but also indicated th possibility of building still better and more economical machines. It was in this fashion that Series T_2 was created. The table below indicates the relative weight index of the machines of all three series.

Capacity in Kilowatts	Relative Weight		
	Old Series	Series T	Series T_2
6,000	100	--	79
12,000	100	88	76
25,000	100	88	72

The successes of contemporary turbogenerator construction are due to achievements in metallurgy and to improvements in the field of ventilation. Advances in metallurgy have made it possible to raise the capacity of the two-pole air-cooled turbogenerator series to 100,000 kilowatts. A machine of this capacity which was produced by the plant in 1937 is still operating.

Hydrogen cooling is the next improvement slated for two-pole generators. The important economical advantages of hydrogen cooling are: a reduction in ventilation losses which increases the efficiency of high-speed machines as much as 1 percent, a reduction in expenditure of operating materials by 15-20 percent, an improvement of machine behavior, and a reduction of operating expenses. In particular, hydrogen cooling eliminates the necessity for regular preventive inspections because the effect of hydrogen under high pressure reduces the amount of dirt clogging which may take place in the machines.

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In addition, the use of hydrogen cooling makes it possible to increase the maximum capacity of the turbogenerator. This capacity increase is possible only with an increase in the rotor diameter, which is impractical with air cooling owing to the extreme ventilation losses.

In 1946, the plant produced its first 100,000-kilowatt turbogenerator with hydrogen cooling. In 1947, it produced its second 25,000-kilowatt hydrogen-cooled turbogenerator.

Beside turbogenerators, the plant produces high-speed (3,000 rpm) asynchronous and synchronous motors of medium and large capacity, required for driving pumps, compressors, and blowers. The development of these machines paralleled that of turbogenerator construction to a considerable degree.

Starting with the production of 3,000-rpm, 450-kilowatt asynchronous short-circuit (korotkozamknutyy) motors, the factory has, to date, created a series of machines with capacities of 500, 700, 850, and 2,000 kilowatts at a voltage of 3 and 6 kilovolts with direct starting from the circuit. The motors have self-lubricating bearings which do not require a complicated pump arrangement to pressure-feed oil.

Synchronous motors which operate at 3,000 rpm are analogous in construction to the turbogenerators of corresponding capacity. The "Elektrosila" plant produces three models which have capacities from 1,000 to 6,000 kilowatts, with reactor or autotransformer starting.

2. Hydroelectric Generators

The progression from Volkhovstroy, Zemo-Avchaly, and Rion hydroelectric-plant type generators to generators of the newest type (Dnepr and Svir hydroelectric-plant types) was made possible by the transition from casting to welding and drop-forge methods of construction, and by the transition from field windings insulated with mica to double-layer or duplex winding with continuous compound insulation.

Mastery of the latest technological processes of production has cut the time involved in generator building. The weight of the various parts has decreased on an average of 20-25 percent in comparison with the former generators. The study of optimum proportions has made it possible to cut the use of copper in hydroelectric generators so that, at present, only 50-60 percent as much copper is used as formerly.

The next improvement in generator construction was the transition to low-speed generators, the so-called umbrella-shape type with the bearing bridge and the step bearing located under the rotor as distinguished from the suspension type in which they are located above the rotor. "Elektrosila" began construction of the umbrella-shape type generator in 1934.

Further improvements are: the transition to segmentary self-lubricating step bearings and ball bearings, the elimination of complex oil-circulating systems, the adoption of new ventilation systems, and the transition to all-welded crossbeams and rotor frames.

Stator windings of the bar type have replaced the coil variety in the majority of cases. This raises the stability of coil instuation to the level of shell insulation. In addition, damper winding is used for generators operating on mercuric-rectifying or single-phase load.

Water-power resources will be much developed to increase the country's electrical base during the Fourth Five-Year Plan. This will require increasing both the total output of generators, and the capacity of individual units.

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3. Direct-Current Machines

The demand by metallurgical plants for electric motors with wide-range speed control to be used in large rolling mills, blooming mills, slab mills, general-purpose mills, and others, was a strong stimulus for the development of direct-current machine building. In 1931 "Elektrosila" produced its first large electrical machines for a blooming mill, a 7,000-hp motor operating at 50-120 rpm. Then followed production of electrical machine equipment for a number of mills. In 1936-1937, electrical equipment for a slab and sheet mill of Zaporozhstal' was produced. Of the many large direct-current machines produced in the following years, we should mention electric motors with ratings of 7,000 hp and speeds of 40-80 rpm, and the Leonard aggregate with a capacity of 4,000 kilowatts for each generator.

More recently, "Elektrosila" has succeeded in building direct-current machines which approach maximum commutation and which have record-breaking capacity. As examples, we might cite the twin direct-current 21,000-hp, 214-rpm motors and the electrical equipment for the slab mill. The period of direct-current machine building was accompanied by research work in the technical assembly of commutators, improvement of collector apparatuses, optimum commutation, damper windings, and special windings.

The plant has mastered production of a new set of direct-current series machines which, by their technical and economical properties, compare favorably with contemporary machines.

Considerable work has been done in perfecting the exciters of synchronous machines. In recent years, new turboexciters of increased reliability have been produced.

4. Alternating-Current Machines

Turbogenerators, hydroelectric generators, and rolling-mill motors were not built by "Elektrosila" before the Revolution. Production of these items began under the Soviets. Prerevolutionary designs were unsatisfactory for production of alternating-current series machines. In the reconstruction period after 1918, it became necessary to examine existing series machines with a view to reducing the number of types and to simplifying the technological process to increase output. Production of small machines was transferred to a newly built plant for standard machines, operating on the assembly-line method. The old series of asynchronous small-size motors of up to 10 kilowatts was replaced by Motor Series A. In 1929-1930, a series greatly lightened (up to 50 percent) by the introduction of forced axial ventilation, was designated Motor Series I.

In 1932, Series I was improved and designated I_2. In 1937, it was replaced by Series AD, designed in a number of standardized sizes.

At the beginning of the Second Five-Year Plan (1932-1933), "Elektrosila" along with other plants designed alternating-current series machines with an average capacity of over 100 kilowatts. In 1935, Series AM was established as the All-Union asynchronous machine with an average capacity of over 100 kilowatts.

The synchronous compensator series was also modified and strengthened.

The weight of contemporary alternating-current machines is about half that of prerevolutionary types.

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